37 16. The 2000 series aluminum alloy of claim 31 wherein said alloy improves by a minimum of 7.5% compared to the average values of standard 2324-T39 alloy shown in Fig. 1 for the same properties selected from the group consisting of the plane strain fracture toughness, K_{Ic}, the plane stress fracture toughness, K_{app}, the stress intensity factor range, ΔK, at a fatigue crack growth rate of 10 μ-inch/cycle wherein R = 0.1 and RH is greater than 90%, and combinations thereof.

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REMARKS

Claims 1-40 stand rejected under 35 U.S.C. § 103(a) for obviousness over U.S. Patent No. 5,863,359 to Karabin et al. in view of U.S. Patent No. 5,213,639 to Colvin et al. Applicants respectfully traverse this rejection for the following reasons.

The present invention is directed to a 2000 series aluminum alloy containing copper, magnesium, and manganese, and optionally including other alloying elements (silicon, iron, and titanium and beryllium) with no other alloying elements other than aluminum and incidental elements and impurities. The alloy of the present invention is recrystallized and does not include zirconium.

The Karabin et al. patent discloses a substantially **un**recrystallized aluminum alloy containing zirconium. It is well established and has been demonstrated on the record that zirconium prevents an aluminum alloy product from recrystallizing. There is no motivation in the Karabin et al. patent to remove zirconium since the patent requires that the alloys described therein are unrecrystallized and aircraft components made thereof should be substantially unrecrystallized. For example, the "Summary of the Invention" at col. 2, lines 46-60 states:

> It is yet another objective to produce an **unrecrystallized Al-Cu-Mg-Mn alloy** products [sic] with enhanced aerospace structural performance. ...
>
> These and other advantages of this invention are achieved with a lower wing skin for a

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> commercial jet aircraft comprised of a substantially **unrecrystallized** rolled plate member made from an aluminum alloy consisting essentially of about 3.6 to 4.2 wt. % copper, about 1.0 to 1.6 wt. % magnesium, about 0.3 to 0.8 wt. % manganese, **about 0.05 to 0.25 wt. % zirconium**, the balance aluminum and incidental elements and impurities. (Emphasis added.)

The Karabin et al. patent specifically discloses an unrecrystallized 2000 type alloy containing Zr with improved properties over alloy 2324-T39. Based on the Karabin et al. patent, one skilled in the art would expect that eliminating Zr would significantly alter the nature of the alloy (allow the alloy to be recrystallized) and would be detrimental to the alloy properties. There is no motivation in the Karabin et al. patent to eliminate Zr.

The Colvin et al. patent, in particular column 3, lines 24-32, has been cited to supplement the absence of a teaching in the Karabin et al. patent to eliminate Zr. The cited portion of the Colvin et al. patent states as follows:

> **Zr could be added** up to 0.5% Zr, with a range for Zr being 0.05 to 0.15 or 0.2 or 0.25%, such as **if it is desired to make an unrecrystallized product** such as a product wherein no more than 20 or 25 vol.% of the product is recrystallized. At levels of Zr above about 0.12%, coarse primary Zr-bearing particles might be formed in casting and these can be detrimental to toughness, unless care is taken to avoid such. (Emphasis added.)

The first sentence quoted above teaches that Zr can be included in an aluminum alloy to make an unrecrystallized product. This teaching is consistent with the Karabin et al. patent and the record—inclusion of Zr creates an unrecrystallized alloy product.

The second quoted sentence teaches that when Zr is included at levels over 0.12%, coarse particles may be formed which could be detrimental to toughness. The

patent recommends that above 0.12% Zr, particular care should be taken in order to avoid such particles from forming. In other words, various exotic processing steps are needed to avoid forming zirconium particles at high Zr levels, i.e. above 0.12% Zr. For example, if Zr is included in the alloy at amounts of 0.13%, very high temperature processing (an example of special "care") can avoid formation of coarse primary Zr-bearing particles.

The zirconium itself is not considered to be the problem. The only problem identified in the Colvin et al. patent with Zr is its use at levels of over 0.12%. The Colvin et al. patent only teaches that exceeding the solubility of zirconium (over 0.12% in the alloys of the Colvin et al. patent) may be detrimental to casting of the alloy.

The Colvin et al. patent does not say that Zr should be avoided in any particular circumstance and does not provide any motivation not to use Zr at all. At most, the patent indicates that care must be used when including Zr. When the Zr level is about 0.12% or less, casting problems are not anticipated. However, at levels above 0.12%, care must be taken to avoid casting problems. This teaching does not indicate Zr should not be included. Actually, the Colvin et al. patent says that Zr could be added up to 0.5% in order to make an unrecrystallized product.

In sum, the cited passage of the Colvin et al. patent teaches that (i) up to 0.5 % Zr can be included to produce an unrecrystallized aluminum alloy product and (ii) care should be taken when processing an alloy containing higher than 0.12% Zr to maintain toughness.

The only discussion on the impact of Zr on alloy properties in the Colvin et al. patent concerns the solubility of Zr at levels above 0.12%. It does not teach or suggest avoiding Zr to maintain toughness, but only that toughness may be affected when including high levels of Zr, over 0.12%. In other words, the Colvin et al. patent teaches that alloy toughness is not of concern at Zr levels of 0.12% or less.

There is nothing in the Colvin et al. patent which guides one skilled in the art to use Zr **or to not use Zr** in order to improve properties including those exhibited in Fig.1 of the present application as recited in claims 1 and 11-16. It does not indicate that any improvement in alloy properties is expected by eliminating Zr. Hence, the Colvin et

al. patent (as well as the Karabin et al. patent) lacks motivation to avoid Zr to achieve superior alloy properties.

Accordingly, the combination of the teachings of the Colvin et al. and Karabin et al. patents does not render obvious the claimed invention that excludes Zr yet achieves superior properties over alloy 2324-T39. Claims 1-40 are believed to define over the prior art of record.

Claim 3 further defines the total copper and total magnesium in the claimed alloy. The prior art of record does not teach or suggest an alloy having the composition of claim 3 along with the particular relationship of total copper (Cu_{targ}) to effective copper (Cu_{eff}) and heat treatments which result in the improved properties required by claim 1.

Regarding claim 2 and dependent claims 11-17, 19 and 20, the prior art of record further fails to teach the specific composition within the box of WXYZ shown in Fig. 5. Contrary to the assertion in the Office Action, the abstract of Karabin et al. patent includes no disclosure on the limitations in claim 2 of (i) the relationship of the effective amounts of copper and magnesium (Cu_{eff} and Mg_{eff}) at the solution heat treatment temperatures shown in Fig. 5 or (ii) the mathematical relationship of total copper (Cu_{targ}) to effective copper (Cu_{eff}).

Finally, upon a recent review of the application, a few typographical errors have been noted. In particular, the sentence at the end of the first paragraph at page 4 contains typographical errors. The correct disclosure of the preferred composition appears in the sentence bridging pages 3 and 4. Accordingly, the sentence in error has been deleted. Two other typographical errors ("is" and "plain") appear at page 4 and have been corrected. A typographical error in the term "percent" in claim 1 has been corrected. Claim 3 (directed to a preferred composition) has been amended to be consistent with the "Summary of the Invention" on page 3. Claims 1 and 11-16 have been amended to insert a comma after "ΔK" to correct a typographical error. Claims 1 and 11-16 also are amended to delete the phrase "maintains the yield strength and" to simplify the claim language regarding the improved properties of the claimed invention.

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These amendments to claims 1, 3, and 11-16 do not affect the patentability of the invention and are imposed only to clarify the language of the claims and to avoid typographical errors. No new matter has been added. Allowance of claims 1-40 is respectfully requested.

Respectfully submitted,

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PATENT TRADEMARK OFFICE

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Marked-Up Specification Paragraphs

The present invention is directed to the 2000 series composition aluminum alloys as defined by the Aluminum Association wherein the composition comprises in weight percent about 3.60 to 4.25 copper, about 1.00 to 1.60 magnesium, about 0.30 to 0.80 manganese, no greater than 0.05 silicon, no greater than 0.07 iron, no greater than 0.06 titanium, no greater than 0.002 beryllium, the remainder aluminum and incidental elements and impurities. Preferably, the composition comprises in weight percent 3.85 to 4.05 copper, 1.25 to 1.45 magnesium, 0.55 to 0.65 manganese, no greater than 0.04 silicon, no greater than 0.05 iron, no greater than 0.04 titanium, no greater than 0.002 beryllium, the remainder aluminum and incidental elements and impurities. When citing a range of the alloy composition, the range includes all intermediate weight [percent's] percents such as for magnesium, 1.00 would include 1.01 or 1.001 on up through and including 1.601 up to 1.649. This incremental disclosure includes each component of the present alloy. [A preferred Cu_{target} composition is about 4.05 to about 4.28 companion to a Mg_{target} composition of about 1.25 to about 1.40 all in weight percent with the remaining constituents the same as in the before stated composition.]

In the practice of the invention, the heat treating temperature, T_{max}, should be controlled at as high a temperature as possible while still being safely below the lowest incipient melting temperature of the alloy, which is about 935°F (502°C). The observed improvements [is] are selected from the group consisting of [plain] plane strain and plane stress fracture toughness, fatigue resistance, and fatigue crack growth resistance, and combinations thereof while essentially maintaining the strength, is accomplished by ensuring that the second phase particles derived from Fe and Si and those derived from Cu and/or Mg are substantially eliminated by composition control and during the heat treatment. The Fe bearing second phase particles are minimized by using high purity base metal with low Fe content. While it is desirable to have no Fe or Si at all, but for the commercial cost thereof, a low Fe and Si content according to the preferred composition range described hereinabove is acceptable for the purposes of the present invention.

Marked-Up Version of Claims 1, 3, and 11-16

1. (Three times amended) A 2000 series aluminum alloy consisting essentially of in weight [per cent] percent about 3.60 to 4.25 copper, about 1.00 to 1.60 magnesium, about 0.30 to 0.80 manganese, no greater than about 0.05 silicon, no greater than about 0.07 iron, no greater than about 0.06 titanium, no greater than about 0.002 beryllium, the remainder aluminum and incidental elements and impurities, wherein a T_{max} heat treatment is below the lowest incipient melting temperature for a given 2000 series alloy composition and the Cu_{target} is determined by the expression:

$$Cu_{target}=Cu_{eff} + 0.74(Mn - 0.2) + 2.28(Fe - 0.005)$$

wherein said alloy [maintains the yield strength and] improves by a minimum of 5% compared to the average values of standard 2324-T39 alloy shown in Fig. 1 for the same properties selected from the group consisting of the plane strain fracture toughness, K_{Ic}, the plane stress fracture toughness, K_{app}, the stress intensity factor range, ΔK, at a fatigue crack growth rate of 10 μ-inch/cycle wherein R = 0.1 and RH is greater than 90%, and combinations thereof.

3. (Amended) The 2000 series aluminum alloy of claim 1 wherein the Cu_{target} composition is about [4.05] 3.85 to about [4.28] 4.05 weight percent and the Mg_{target} is about 1.25 to about [1.40] 1.45 weight percent.

11. (Twice amended) The 2000 series aluminum alloy of claim 2 wherein said alloy [maintains the yield strength and] improves by a minimum of 5% compared to the average values of standard 2324-T39 alloy shown in Fig. 1 for the same properties selected from the group consisting of the plane strain fracture toughness, K_{Ic}, the plane stress fracture toughness, K_{app}, the stress intensity factor range, ΔK, at a fatigue crack growth rate of 10 μ-inch/cycle wherein R = 0.1 and RH is greater than 90%, and combinations thereof.

12. (Twice amended) The 2000 series aluminum alloy of claim 2 wherein said alloy [maintains the yield strength and] improves by a minimum of 5.5% compared to the average values of standard 2324-T39 alloy shown in Fig. 1 for the same properties selected from the group consisting of the plane strain fracture toughness, K_{Ic}, the plane stress fracture toughness, K_{app}, the stress intensity factor range, ΔK, at a fatigue crack growth rate of 10 μ-inch/cycle wherein R = 0.1 and RH is greater than 90%, and combinations thereof.

13. (Twice amended) The 2000 series aluminum alloy of claim 2 wherein said alloy [maintains the yield strength and] improves by a minimum of 6% compared to the average values of standard 2324-T39 alloy shown in Fig. 1 for the same properties selected from the group consisting of the plane strain fracture toughness, K_{Ic}, the plane stress fracture toughness, K_{app}, the stress intensity factor range, ΔK, at a fatigue crack growth rate of 10 μ-inch/cycle wherein R = 0.1 and RH is greater than 90%, and combinations thereof.

14. (Twice amended) The 2000 series aluminum alloy of claim 2 wherein said alloy [maintains the yield strength and] improves by a minimum of 6.5% compared to the average values of standard 2324-T39 alloy shown in Fig. 1 for the same properties selected from the group consisting of the plane strain fracture toughness, K_{Ic}, the plane stress fracture toughness, K_{app}, the stress intensity factor range, ΔK, at a fatigue crack growth rate of 10 μ-inch/cycle wherein R = 0.1 and RH is greater than 90%, and combinations thereof.

15. (Twice amended) The 2000 series aluminum alloy of claim 2 wherein said alloy [maintains the yield strength and] improves by a minimum of 7% compared to the average values of standard 2324-T39 alloy shown in Fig. 1 for the same properties selected from the group consisting of the plane strain fracture toughness, K_{Ic}, the plane stress fracture toughness, K_{app}, the stress intensity factor range, ΔK, at a fatigue crack growth rate of 10 μ-inch/cycle wherein R = 0.1 and RH is greater than 90%, and combinations thereof.

16. (Twice amended) The 2000 series aluminum alloy of claim 2 wherein said alloy [maintains the yield strength and] improves by a minimum of 7.5% compared to the average values of standard 2324-T39 alloy shown in Fig. 1 for the same properties selected from the group consisting of the plane strain fracture toughness, K_{Ic}, the plane stress fracture toughness, K_{app}, the stress intensity factor range, ΔK, at a fatigue crack growth rate of 10 μ-inch/cycle wherein R = 0.1 and RH is greater than 90%, and combinations thereof.

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